Climate Research and Modeling (CRM)

To a first approximation:

CRM = Climate Forcing (-Monitoring forcing agents) +
Projections and Predictions

Contains three major capabilities:

- 1. Understand Climate Processes
- 2. Earth System Modeling and Projections
- 3. Analysis and Attributions

Addresses the physical and chemical process studies, representation of the processes in models ranging up to Earth System models, and utilizing these models to derive information.

Climate Research and Modeling (CRM)

FY10-14 Alternatives:

1. Decadal Climate Projections, Predictability, and Predictions (Delworth)
2. Revitalizing NOAA's Climate Computing (Gross/Delworth)
3. Climate and Air Quality (Ravi)
4. Integrated Earth System Reanalysis (Dole)
5. Attribution and Analysis (Dole)

Decadal Climate Projections, Predictability, and Predictions

Starting Point: Projections of future climate change do not start from the observed state of the climate system

Question: Is there any "skill" on decadal time scale projections/predictions if models start from the observed state?

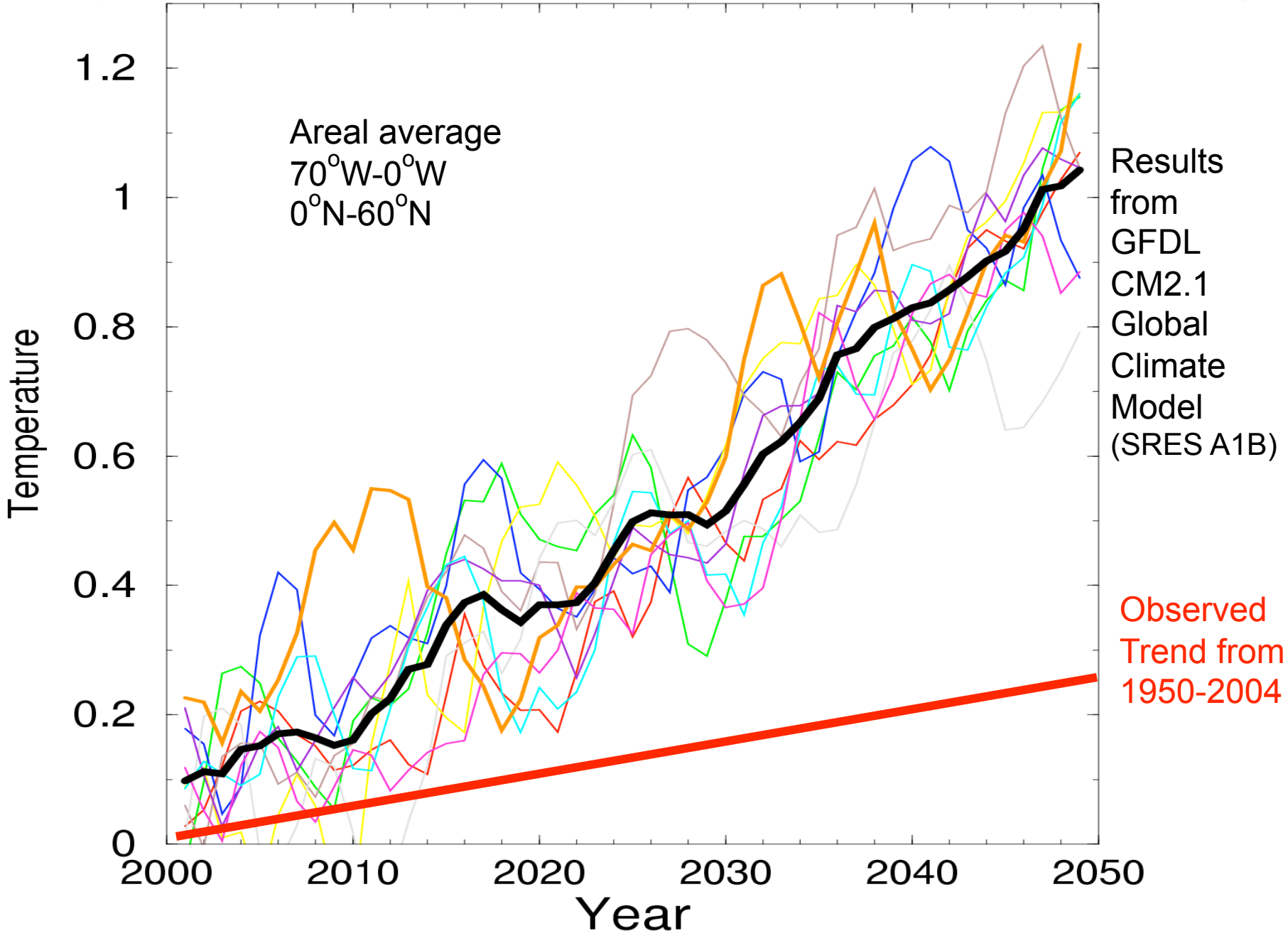
Key goal: Develop the capability to make decadal-scale (1-10 years) projections and predictions of climate variability and change on both global and regional scales.

Variability and change on 1-10 year time scale is a mixture of forced climate change and internal variability. The change may be abrupt.

Requires:

(a) Understanding
(b) Models
(c) Observations

Projected Atlantic SST Change (relative to 1991-2004 mean)



Components of decadal predictions & projections

1. Forced climate change

- Predictability arising from estimates of future changes in radiative forcing agents, and the climate system response to those changes.
- "Committed warming" from past radiative forcing

2. Internal variability

- Interannual to decadal-scale fluctuations have large impacts!
- Is there "meaningful" decadal-scale predictability in the climate system?
- Can we realize that predictability?

What do we need to realize any predictability?

- Observations to initialize models – ARGO is promising
- Assimilation systems (crucial work underway at GFDL)
- Models of sufficient realism (look to higher resolution, improved physics)
- Computational resources
  - Higher resolution
  - Ensembles

What about abrupt climate change?

4 Foci for Abrupt Climate Change (CCSP SAP 3.4)

- **Atlantic Meridional Overturning Circulation (AMOC)**
- **Sustained changes to the hydrologic cycle (droughts, etc)**
- **Rapid changes in land-based ice sheets (Greenland, Antarctica)**
- **Rapid release to the atmosphere of methane trapped in permafrost and continental shelves**

Decadal predictions system initially address first two foci, expands to encompass additional components as models mature.

Revitalizing NOAA's Computing Capability for Climate Projections, Predictability, and Predictions

Crucial demand for climate change information on:

- Regional Scales
- Changes in climate extremes
- Decadal scale Predictions/Projections

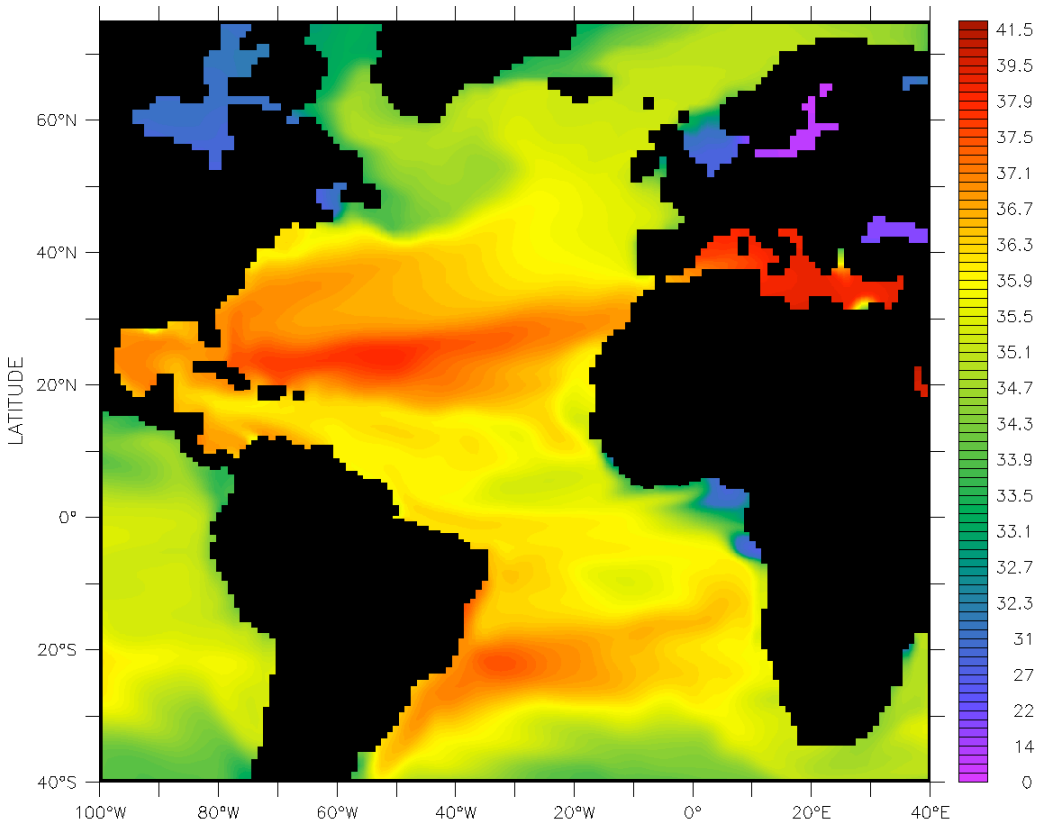
NOAA climate change models are state of the art (IPCC AR4), and high resolution versions have been developed.

In addition, model complexity is increasing rapidly (for example, inclusion of biogeochemical cycles)

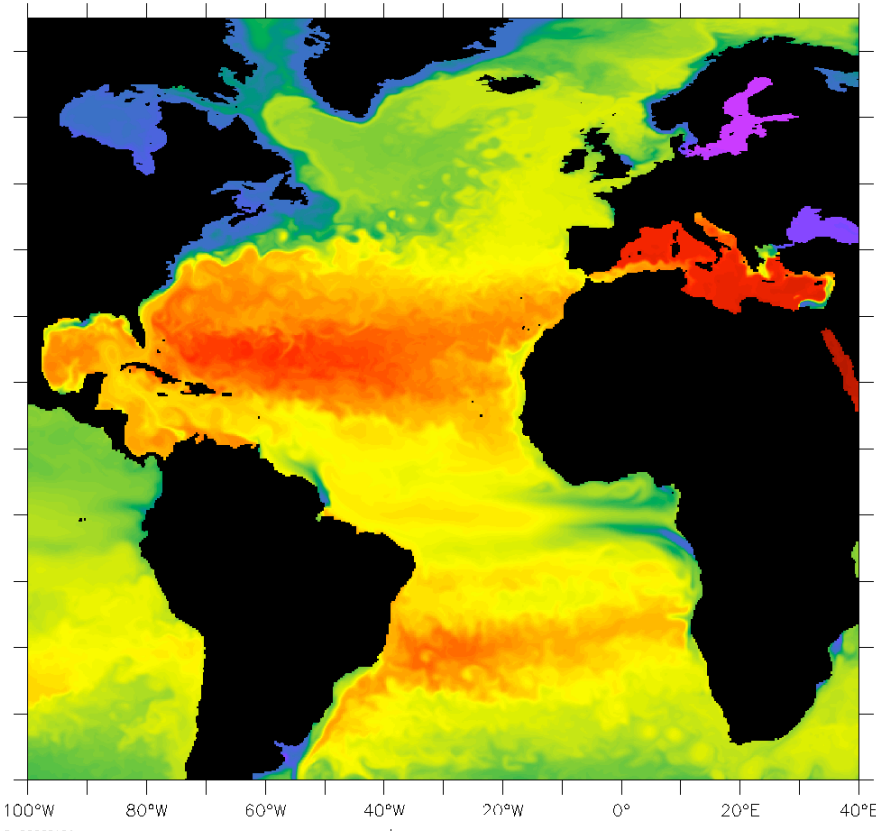
However … NOAA computational resources for climate change lag far behind what is needed.

Progress in ocean modeling

Sea Surface Salinity (AR4 class model)



New high resolution model



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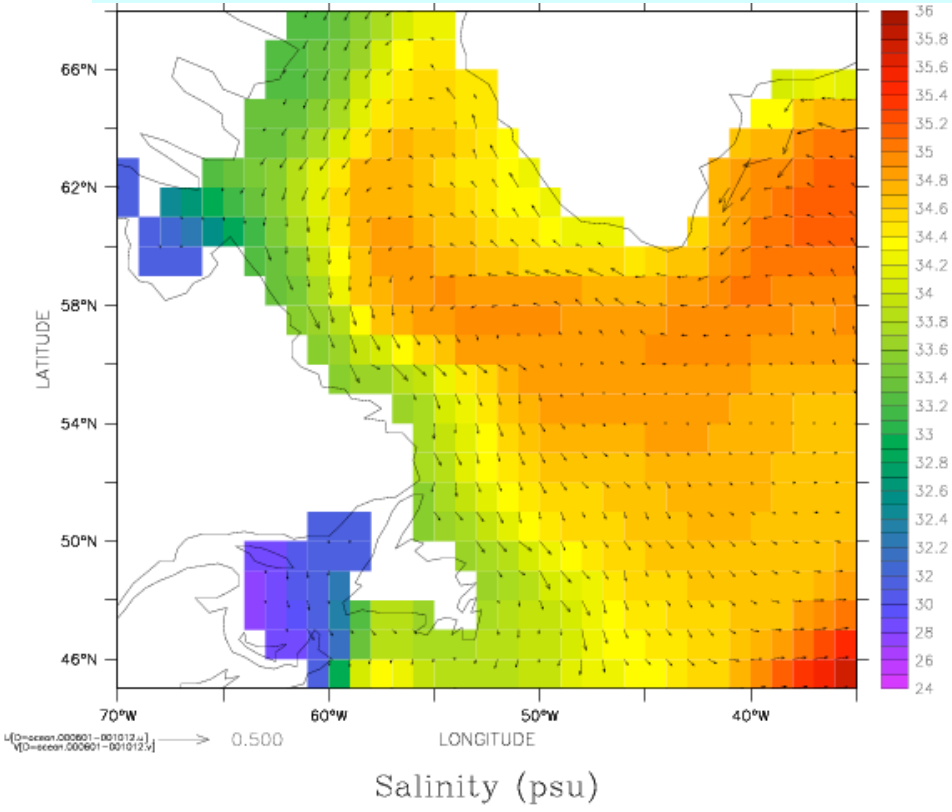
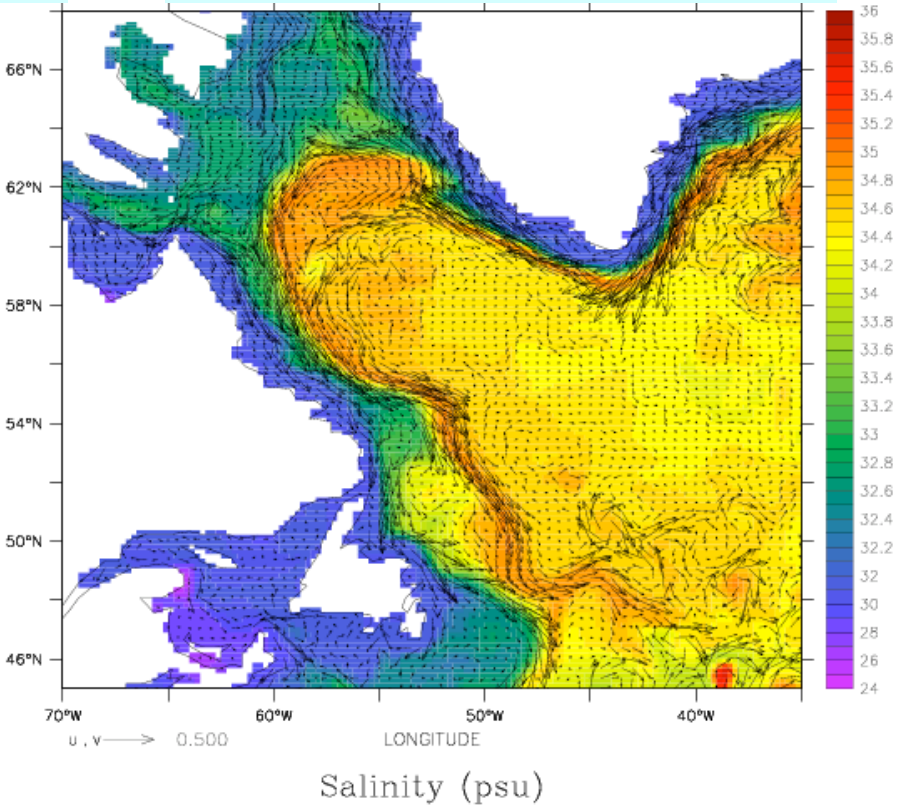
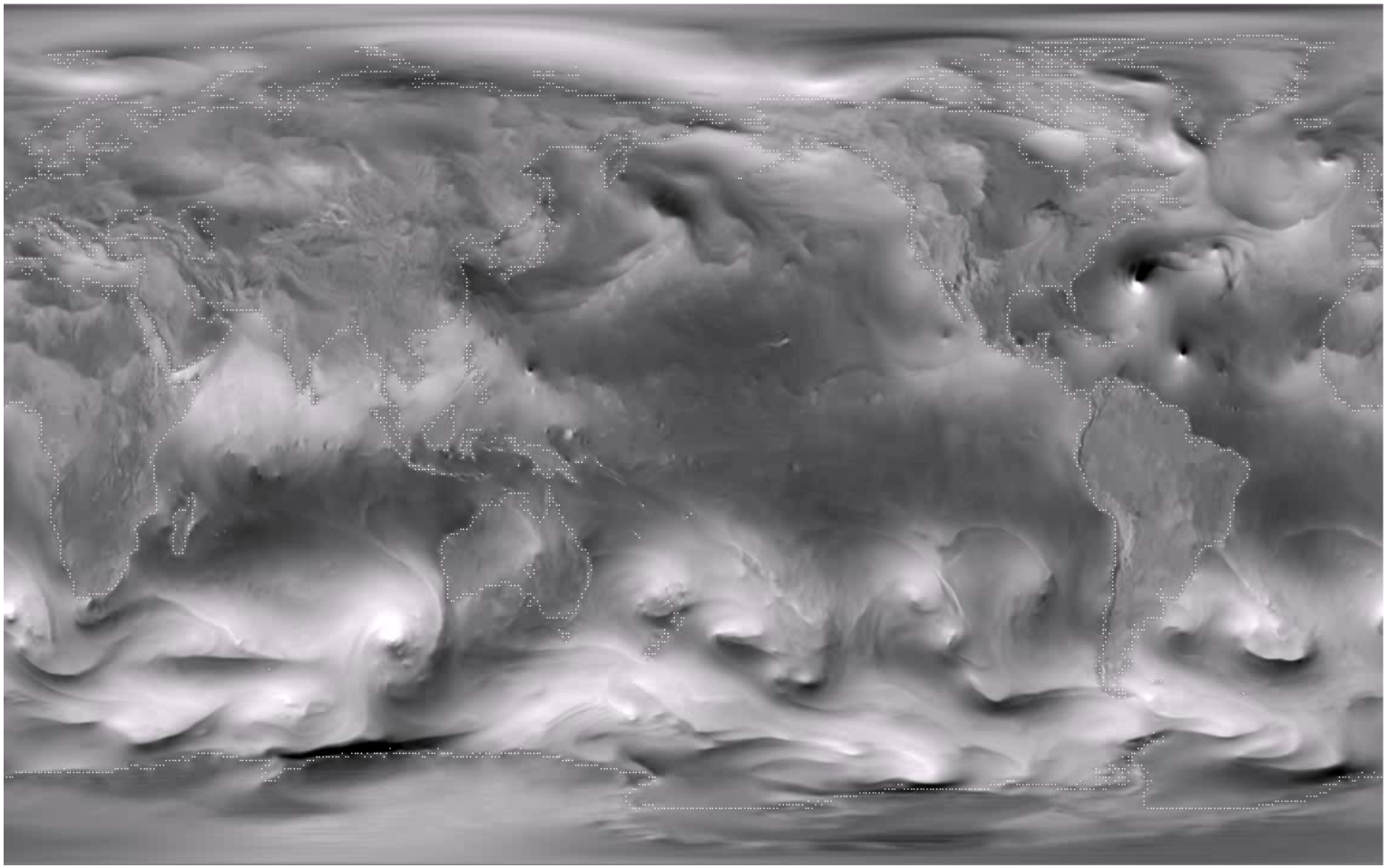


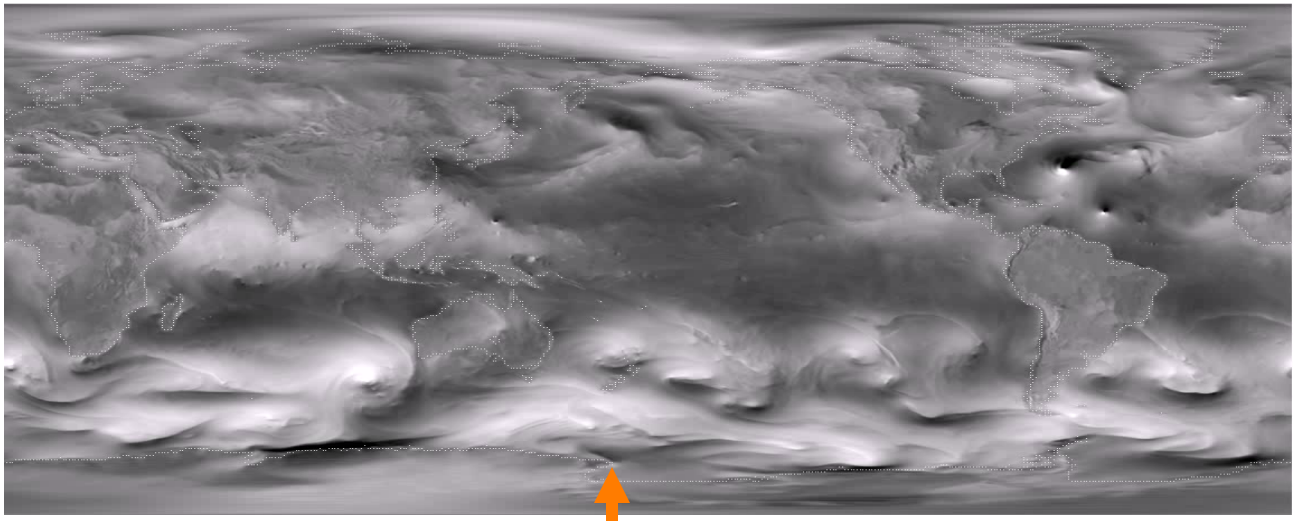
New high resolution model

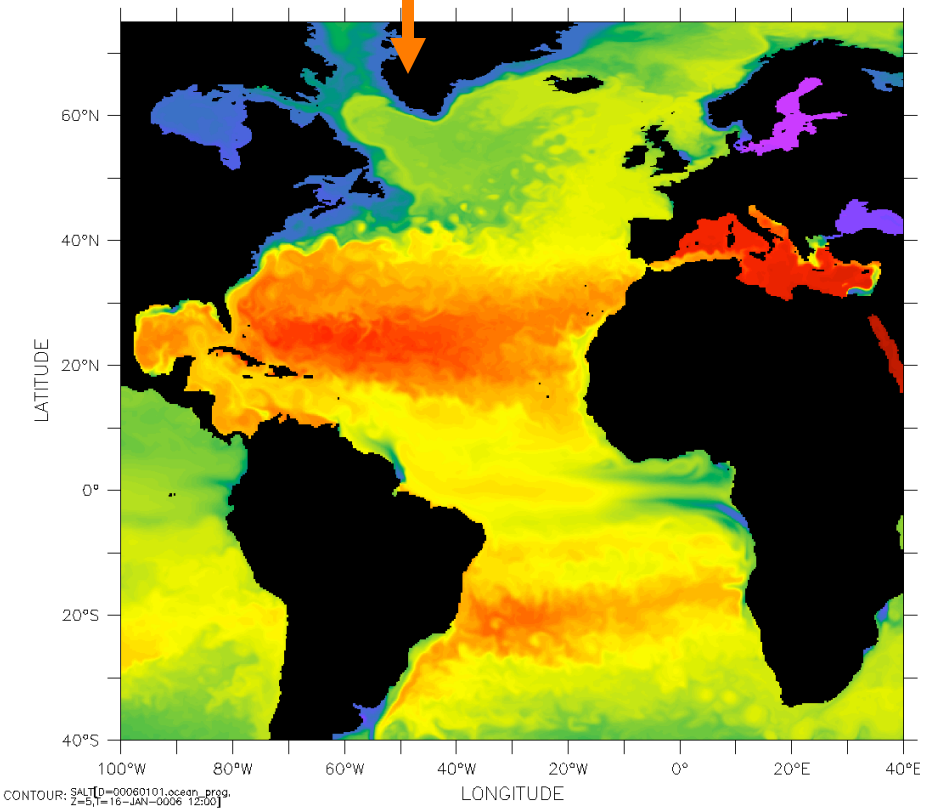


GFDL atmospheric model - ¼ degree

(field shown is near-surface zonal wind)



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